Office of Science
Financial Assistance
Funding Opportunity Announcement
DE-PS02-09ER09-26

THIS IS A RECOVERY ACT ANNOUNCEMENT

RECOVERY ACT (ARRA)
EARLY CAREER RESEARCH PROGRAM

The Office of Science of the Department of Energy hereby invites grant applications for support under the Early Career Research Program in the following program areas: Advanced Scientific Computing Research (ASCR); Biological and Environmental Research (BER); Basic Energy Sciences (BES), Fusion Energy Sciences (FES); High Energy Physics (HEP), and Nuclear Physics (NP). The purpose of this program is to support the development of individual research programs of outstanding scientists early in their careers and to stimulate research careers in the areas supported by the DOE Office of Science.

ELIGIBILITY

The Principal Investigator must be an untenured Assistant Professor on the tenure track at a U.S. academic institution as of the deadline for the application. No more than ten (10) years can have passed between the year the Principal Investigator's Ph.D. was awarded and the year of the deadline for the application (for the present competition, those who received doctorates no earlier than 1999 are eligible).

LETTER OF INTENT

A Letter of Intent, comprising a brief summary of the proposed research (one paragraph), is encouraged and should be submitted by August 3, 2009, 4:30 p.m., Eastern time, to: early.career@science.doe.gov. The letter should clearly state the program area to which the application is being submitted (e.g., BER, BES, HEP, NP, ASCR, FES). Please include the program acronym along with "Early Career Research Program Letter of Intent" in the subject line. For example, the subject line of a letter to the Office of Biological and Environmental Research (BER) would be "BER Early Career Research Program Letter of Intent." Principal Investigators are not required to contact the Office of Science program managers before sending the letter of intent or submitting an application.

APPLICATION DUE DATE: September 1, 2009

<u>Formal applications</u> submitted in response to this FOA must be received by September 1, 2009, 8:00 p.m. Eastern time, to permit timely consideration of awards. **APPLICATIONS**

RECEIVED AFTER THE DEADLINE WILL NOT BE REVIEWED OR CONSIDERED FOR AWARD.

ATTENTION - CHANGE IN SUBMISSION REQUIREMENT EFFECTIVE August 4, 2009:

Applications submitted to the Office of Science must be submitted electronically through Grants.gov to be considered for award. The Funding Opportunity Number is DE-PS02-09ER09-26 and the CFDA Number for the Office of Science is 81.049. Applicants must follow the instructions and use the forms provided on the Grants.gov website.

Registration Requirements: There are several one-time actions you must complete in order to submit an application (e.g., obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number, register with the Central Contract Registry (CCR), register with the credential provider, and register with Grants.gov). See http://www.grants.gov/GetStarted. Use the Grants.gov Organization Registration Checklist at http://www.grants.gov/assets/OrganizationRegCheck.doc to guide you through the process. Designating an E-Business Point of Contact (EBiz POC) and obtaining a special password called an MPIN are important steps in the CCR registration process. Applicants, who are not registered with CCR and Grants.gov, should allow at least 14 days to complete these requirements. It is suggested that the process be started as soon as possible.

GENERAL INQUIRIES ABOUT THIS FOA SHOULD BE DIRECTED TO:

Administrative Contact: Questions about program rules should be sent to early.career@science.doe.gov.

Technical Contact: Questions regarding the specific program areas/technical requirements can be directed to the technical contacts listed for each program within the Notice.

SUPPLEMENTARY INFORMATION:

It is anticipated that up to $25M of Recovery Act funds will be available for grant awards in FY 2010, subject to the availability of funds. The following program descriptions are offered to provide more in-depth information on scientific and technical areas of interest to the Office of Science: Early Career Research Program opportunities exist in the following Office of Science research programs. Additional details about each program, websites, and technical points of contacts are provided in the materials that follow.

I. Advanced Scientific Computing Research (ASCR)
(a) Applied Mathematics
(b) Computer Science
(c) Computational Science
(d) Network-Environment Research

II. Biological and Environmental Research (BER)
(a) Biological Systems Science
(b) Climate and Environmental Sciences

III. Basic Energy Sciences (BES)
(a) Materials Sciences and Engineering
(b) Chemical Sciences, Geosciences, and Biosciences
(c) Scientific User Facilities-Related Research

IV. Fusion Energy Sciences (FES)
(a) Science
(b) Enabling Research & Development

V. High Energy Physics (HEP)
(a) Experimental High Energy Physics Research
(b) Theoretical High Energy Physics Research
(c) Advanced Technology Research and Development

VI. Nuclear Physics (NP)
(a) Medium Energy Nuclear Physics
(b) Heavy Ion Nuclear Physics
(c) Low Energy Nuclear Physics
(d) Nuclear Theory (including the Nuclear Data subprogram)
(e) Accelerator Research and Development for Current and Future Nuclear Physics Facilities
(f) Isotope Development and Production for Research and Applications

I. Advanced Scientific Computing Research (ASCR) Program Website:
http://www.sc.doe.gov/ascr

The mission of the Advanced Scientific Computing Research (ASCR) Program is to deliver forefront computational and networking capabilities to extend the frontiers of science. A particular challenge of this program is fulfilling the science potential of emerging multi-core computing systems and other novel "extreme-scale" computing architectures, which will require significant modifications to today's tools and techniques.

The priority areas for ASCR include:

- To develop mathematical descriptions, models, methods and algorithms to accurately describe and understand the behavior of complex systems involving processes that span vastly different time and/or length scales
- To develop the underlying understanding and software to make effective use of computers at extreme scales To transform extreme scale data from experiments and simulations into scientific insight.
- To advance key areas of computational science and discovery that advance the missions of the Office of Science through mutually beneficial partnerships.

- To deliver the forefront computational and networking capabilities to extend the frontiers of science.
- To develop networking and collaboration tools and facilities that enable scientists worldwide to work together.

The computing resources and high-speed networks required to meet Office of Science needs exceed the state-of- the-art by a significant margin. Furthermore, the algorithms, software tools, the software libraries and the distributed software environments needed to accelerate scientific discovery through modeling and simulation are beyond the realm of commercial interest. To establish and maintain DOE's modeling and simulation leadership in scientific areas that are important to its mission, ASCR operates Leadership Computing facilities, a high-performance production computing center, and a high-speed network and implements a broad base research portfolio in applied mathematics, computer science, computational science and network research to solve complex problems on computational resources that are on a trajectory to reach well beyond a petascale within a few years. Research areas of interest include:

(a) Applied Mathematics
Technical Contact: Sandy Landsberg, 301-903-8507, sandy.landsberg@science.doe.gov

This program supports research on the mathematical models, methods and numerical algorithms to accurately describe, understand and predict the behavior of complex physical, chemical, biological, and engineered systems.

For example, the topics of supported research efforts may include: (1) numerical methods for the parallel solution of systems of partial differential equations, large- scale linear or nonlinear systems, or very large parameter-estimation problems; (2) analytical or numerical techniques for modeling complex physical, biological or engineered phenomena, such as fluid turbulence, microbial populations or networked systems; (3) analytical or numerical methods for bridging a broad range of temporal and spatial scales; (4) optimization, control, coupling techniques and risk analysis of complex systems, such as computer networks and electrical power grids; and (5) mathematical research issues related to extreme scale science and analysis of petascale data.

(b) Computer Science
Technical Contact: Lucy Nowell, 301-903-3191, lucy.nowell@science.doe.gov

This program supports research to advance extreme scale computing and data. Research topics include scalable and fault tolerant operating systems, programming models, performance modeling and assessment tools, development tools, interoperability and infrastructure methodology, and large scale data management and visualization. The development of new computer and computational science techniques will allow scientists to use the most advanced computers without being overwhelmed by the complexity of rewriting their codes with each new generation of high performance architectures.

(c) Computational Science
Technical Contact: Lali Chatterjee, 301-903-7379, lali.chatterjee@science.doe.gov

This program supports research in pioneering science applications for the next generations of high performance computers.

Research topics include the development of transformative new science application software, techniques and methods and the development of advanced collaboratory, data management and visualization tools. The development of new computational science techniques will allow scientists to tap the potential of extreme scale computers to advance science.

(d) Network Environment Research
Technical Contact: Thomas Ndousse-Fetter, 301-903-9960, tndousse@ascr.doe.gov

This program supports research to develop and deploy a high-performance network and collaborative technologies to support distributed high-end science applications and large-scale scientific collaborations.

The current focus areas include but are not limited to cyber security systems, dynamic bandwidth allocation services, network measurement and analysis, ultra high-speed transport protocols, fault tolerance, self correction techniques, and advanced application layer services. The development of the next generation of networks will allow scientists to effectively and efficiently access and use distributed resources, such as advanced services for group collaboration, secure services for remote access of distributed resources, and innovative technologies for sharing, controlling, and managing distributed computing resources.

Proposed research may include one or more of the areas listed above.

II. Biological and Environmental Research (BER)
Program Website: http://www.sc.doe.gov/ober

The mission of the Biological and Environmental Research (BER) program is to understand complex biological, climatic, and environmental systems across spatial and temporal scales ranging from sub-micron to the global, from individual molecules to ecosystems, and from nanoseconds to millennia. This is accomplished by exploring the frontiers of genome-enabled biology; discovering the physical, chemical and biological drivers of climate change; and seeking the geochemical, hydrological, and biological determinants of environmental sustainability and stewardship.

(a) Biological Systems Science
Technical Contact: Marvin Stodolsky, 301-903-4475, marvin.stodolsky@science.doe.gov

Research is focused on using DOE's unique resources and facilities to develop fundamental knowledge of biological systems that can be used to address DOE needs in clean energy, carbon sequestration, and environmental cleanup and that will underpin biotechnology-based solutions to energy challenges. The objectives are: (1) to develop the experimental and, together with the ASCR program, the computational resources, tools, and technologies needed to understand and predict complex behavior of complete biological systems, principally microbes and microbial communities; (2) to take advantage of the remarkable high throughput and cost-effective DNA sequencing capacity at the Joint Genome Institute to meet the DNA sequencing needs of the scientific community through competitive, peer-reviewed nominations for DNA sequencing; (3) to understand and characterize the risks to human health from exposures to low levels of ionizing radiation; (4) to operate experimental biological stations at synchrotron and neutron sources; (5) to anticipate and address ethical, legal, and social implications arising from Office of Science-supported biological research, especially synthetic biology, sustainability, and nanotechnology and (6) to develop radiochemistry and advanced technologies for imaging and high through-put characterization and analysis for BER missions in bioenergy, subsurface, and climate change.

(b) Climate and Environmental Sciences
Technical Contact: Robert W. Vallario, 301-903-5758, bob.vallario@science.doe.gov

The program seeks to understand the basic physical, chemical, and biological processes of the Earth's System and how these processes may be affected by energy production and use. Research is designed to provide data to enable an objective, scientifically based assessment of the potential for, and the consequences of, human-induced climate change at global and regional scales. The program also provides data and models to enable assessments of mitigation options to prevent such change. The program is comprehensive with emphasis on: (1) understanding and simulating the radiation balance from the surface of the Earth to the top of the atmosphere, including the effect of clouds, water vapor, trace gases, and aerosols. (The Atmospheric Radiation Measurement Climate Research Facility provides key observational data to the climate research community on the radiative properties of the atmosphere, especially clouds and aerosols. This national user facility includes highly instrumented ground stations, a mobile facility, and an aerial vehicles program.; (2) enhancing and evaluating the quantitative models necessary to predict natural climatic variability and possible human- caused climate change at global and regional scales; (3) understanding and simulating the net exchange of carbon dioxide between the atmosphere, and terrestrial systems, as well as the effects of climate change on the global carbon cycle; (4) understanding ecological effects of climate change; (5) improving approaches to integrated assessments of effects of, and options to mitigate, climatic change; (6) basic research directed at understanding options for sequestering excess atmospheric carbon dioxide in terrestrial ecosystems, including potential environmental implications of such sequestration; (7) subsurface biogeochemical research to understand and predict subsurface contaminant fate and transport; and (8) take advantage of the national user facility, the Environmental Molecular Sciences Laboratory (EMSL) that houses an unparalleled collection of state-of-the-art capabilities, including a supercomputer and over 60 major instruments, providing integrated experimental and computational resources for discovery and technological innovation in the environmental molecular sciences. EMSL also contributes to systems biology by providing leading edge capabilities in proteomics.

III. Basic Energy Sciences (BES)
Program Website: http://www.sc.doe.gov/bes

The mission of the Basic Energy Sciences (BES) program is to support fundamental research to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels in order to provide the foundations for new energy technologies and to support other aspects of DOE missions in energy, environment, and national security. The portfolio supports work in the natural sciences by emphasizing fundamental research in materials sciences, chemistry, geosciences, and physical biosciences.

The four long-term goals in scientific advancement that the BES program is committed to and against which progress can be measured are:

- Design, model, fabricate, characterize, analyze, assemble, and use a variety of new materials and structures, including metals, alloys, ceramics, polymers, biomaterials and more-particularly at the nanoscale-for energy-related applications.
- Understand, model, and control chemical reactivity and energy transfer processes in the gas phase, in solutions, at interfaces, and on surfaces for energy-related applications, employing lessons from inorganic and biological systems.
- Develop new concepts and improve existing methods to assure a secure energy future, e.g., for solar energy conversion and for other energy sources.
- Conceive, design, fabricate, and use new scientific instruments to characterize and ultimately control materials, especially instruments for x-ray, neutron, and electron beam scattering and for use with high magnetic and electric fields.

The BES science subprograms and their objectives are as follows:

(a) Materials Sciences and Engineering
Technical Contact: Linda Horton, 301-903-7506, linda.horton@science.doe.gov

The objective of this subprogram is to support fundamental experimental and theoretical research to provide the knowledge base for the discovery and design of new materials with novel structures, functions, and properties. These research activities emphasize the design and synthesis of materials; the characterization of their structure and defect state; the understanding of their physical, chemical, and irradiation-induced behaviors over multiple length and time scales; and the development and advancement of new experimental and computational tools and techniques. The main research elements of the subprogram are condensed matter and materials physics; scattering and instrumentation sciences; and materials discovery, design, and synthesis. In condensed matter and materials physics - including activities in experimental condensed matter physics, theoretical condensed matter physics, mechanical behavior and radiation effects, and physical behavior of materials - research is supported to understand, design, and control materials properties and function. These goals are accomplished through studies of the relationship of materials structures to their electrical, optical, magnetic, surface reactivity, and mechanical properties and the way in which materials respond to external forces such as stress, chemical and electrochemical environments, radiation, and the proximity of materials to surfaces and interfaces. The activity emphasizes correlation effects, which can lead to the formation of new particles, new phases of matter, and unexpected phenomena. The theoretical efforts focus on the development of advanced computer algorithms and codes to treat large or complex systems. In scattering and instrumentation sciences - including activities in neutron and x-ray scattering and electron and scanning microscopies - research is supported on the fundamental interactions of photons, neutrons, and electrons with matter to understand the atomic, electronic, and magnetic structures and excitations of materials and the relationship of these structures and excitations to materials properties and behavior. Major research areas include fundamental dynamics in complex materials, correlated electron systems, nanostructures, and the characterization of novel systems. The development of next-generation neutron, x-ray, and electron microscopy instrumentation is a key element of this portfolio.

In materials discovery, design, and synthesis - including activities in synthesis and processing science, materials chemistry, and biomolecular materials - research is supported in the discovery and design of novel materials and the development of innovative materials synthesis and processing methods. Major research thrust areas include nanoscale synthesis, organization of nanostructures into macroscopic structures, solid state chemistry, polymers and polymer composites, surface and interfacial chemistry including electrochemistry and electro-catalysis, and synthesis and processing science including biomimetic and bioinspired routes to functional materials and complex structures.

(b) Chemical Sciences, Geosciences, and Biosciences
Technical Contact: Eric Rohlfing, 301-903-8165, eric.rohlfing@science.doe.gov

The objective of this subprogram is to support fundamental research enabling the understanding of chemical transformations and energy flow in systems relevant to DOE missions. This knowledge serves as a basis for the development of new processes for the generation, storage, and use of energy and for mitigation of the environmental impacts of energy use. New experimental techniques are developed to investigate chemical processes and energy transfer over a wide range of spatial and temporal scales: from atomic to kilometer spatial scales and from femtosecond to millennia time scales. Theory, modeling, and computational simulations are performed, from detailed quantum calculations of chemical properties and reactivity to multi-scale simulations of combustion devices. The main research activities within the subprogram are fundamental interactions; photo- and biochemistry; and chemical transformations. In fundamental interactions, basic research is supported in atomic, molecular and optical sciences; gas-phase chemical physics; ultrafast chemical science; and condensed phase and interfacial molecular science. Emphasis is placed on structural and dynamical studies of atoms, molecules, and nanostructures, and the description of their interactions in full quantum detail, with the aim of providing a complete understanding of reactive chemistry in the gas phase, condensed phase, and at interfaces. Novel sources of photons, electrons, and ions are used to probe and control atomic, molecular, and nanoscale matter. Ultrafast optical and x-ray techniques are developed and used to study chemical dynamics. There is a focus on cooperative phenomena in complex chemical systems, such as the effect of solvation on chemical structure, reactivity, and transport and the coupling of complex gas-phase chemistry with turbulent flow in combustion.

In photo- and biochemistry, including solar photochemistry, photosynthetic systems, and physical biosciences, research is supported on the molecular mechanisms involved in the capture of light energy and its conversion into chemical and electrical energy through biological and chemical pathways. Natural photosynthetic systems are studied to create robust artificial and bio-hybrid systems that exhibit the biological traits of self assembly, regulation, and self repair. Complementary research encompasses organic and inorganic photochemistry, photo-induced electron and energy transfer, photoelectrochemistry, and molecular assemblies for artificial photosynthesis. Inorganic and organic photochemical studies provide information on new chromophores, donor-acceptor complexes, and multi-electron photocatalytic cycles.

Photoelectrochemical conversion is explored in studies of nanostructured semiconductors at liquid interfaces. Biological energy transduction systems are investigated, with an emphasis on the coupling of plant development and microbial biochemistry with the experimental and computational tools of the physical sciences.

In chemical transformations, the themes are characterization, control, and optimization of chemical transformations, including efforts in catalysis science; separations and analytical science; actinide chemistry; and geosciences. Catalysis science underpins the design of new catalytic methods for the clean and efficient production of fuels and chemicals and emphasizes inorganic and organic complexes; interfacial chemistry; nanostructured and supramolecular catalysts; photocatalysis and electrochemistry; and bio-inspired catalytic processes. Heavy element chemistry focuses on the spectroscopy, bonding, and reactivity of actinides and fission products; complementary research on chemical separations focuses on the use of nanoscale membranes and the development of novel metal-adduct complexes. Chemical analysis research emphasizes laser-based and ionization techniques for molecular detection, particularly the development of chemical imaging techniques. Geosciences research covers analytical and physical geochemistry, rock-fluid interactions, and flow/transport phenomena; this research provides a fundamental basis for understanding the environmental contaminant fate and transport and for predicting the performance of repositories for radioactive waste or carbon dioxide sequestration.

(c) Scientific User Facilities-Related Research
Technical Contact: Pedro Montano, 301-903-2347, pedro.montano@science.doe.gov

This subprogram supports the R&D, planning, and operation of scientific user facilities for the development of novel nano-materials and for materials characterization through x-ray, neutron, and electron beam scattering. The main research elements of the subprogram are accelerator and detector research for light sources and neutron scattering facilities, electron-beam micro-characterization, nanoscale science and engineering, and the development and use of x-ray and neutron scattering to address scientific problems of interest to the two subprograms described in (a) and (b) above. All of these research elements are in the context of serving the needs of the Scientific User Facilities.

In accelerator and detector research the objective is to improve the output and capabilities of synchrotron radiation light sources and neutron scattering facilities that are the most advanced of their kind in the world. This program supports basic research in accelerator physics and x-ray and neutron detectors. Research is supported that seeks to achieve a fundamental understanding beyond the traditional accelerator science and technology in order to develop new concepts to be used in the design of new accelerator facilities for synchrotron radiation and spallation neutron sources. To exploit fully the fluxes delivered by synchrotron radiation facilities and spallation neutron sources, new detectors capable of acquiring data several orders of magnitude faster are required. Improved detectors are especially important in the study of multi-length scale systems such as protein- membrane interactions as well as nucleation and crystallization in nanophase materials. They will also enable real-time kinetic studies and studies of weak scattering samples. This program strongly interacts with BES programmatic research that uses synchrotron radiation and neutron sources.

In the area of electron-beam microcharacterization the focus is on the development of next-generation electron-beam instrumentation and on conducting corresponding research. Electron scattering has key attributes that give such approaches unique advantages and make them complementary to x-ray and neutron beam techniques. These characteristics include strong interactions with matter (allowing the capture of meaningful signals from very small amounts of material, including single atoms under some circumstances) and the ability to readily focus the charged electron beams using electromagnetic lenses. The net result is unsurpassed spatial resolution and the ability to simultaneously get structural, chemical, and other types of information from subnanometer regions, allowing study of the fundamental mechanisms of catalysis, energy conversion, corrosion, charge transfer, magnetic behavior, and many other processes. All of these are fundamental to understanding and improving materials for energy applications and the associated physical characteristics and changes that govern performance. Instrumentation and technique development efforts are supported in areas including scanning, transmission, and scanning transmission electron microscopes, atom probes and related field ion instruments, related surface characterization apparatus and scanning probe microscopes, and ancillary tools such as spectrometers, detectors, and advanced sample preparation equipment.

Nanoscience research is focused at the following five Nanoscale Science Research Centers, which support the synthesis, processing, fabrication, and analysis of materials at the nanoscale: the Center for Nanophase Materials Sciences at ORNL, the Molecular Foundry at LBNL, the Center for Integrated Nanotechnologies at SNL/LANL, the Center for Nanoscale Materials at ANL, and the Center for Functional Nanomaterials at BNL. These facilities are the Department of Energy's premier user centers for interdisciplinary research at the nanoscale, serving as the basis for a national program that encompasses new science, new tools, and new computing capabilities. As such, research is supported in a wide variety of scientific disciplines including materials derived from or inspired by nature, hard and crystalline materials (including the structure of macromolecules), magnetic and soft materials (including polymers and ordered structures in fluids), and nanotechnology integration.

IV. Fusion Energy Sciences (FES)

Program Website: http://www.sc.doe.gov/ofes

The mission of the Fusion Energy Sciences (FES) program is to expand the fundamental understanding of matter at very high temperatures and densities and to build the scientific foundations needed to develop a fusion energy source. This is accomplished by studying plasmas under a wide range of temperature and density conditions, developing advanced diagnostics to make detailed measurements of plasma properties, and creating theoretical/computational models to resolve the essential physics.

The FES program contributes to the Department's Energy Security goal through participation in ITER, an experiment to study and demonstrate the sustained burning of fusion fuel. ITER will provide an unparalleled scientific research opportunity and will test the scientific and technical feasibility of fusion power. The ITER Agreement was signed and ratified by the ITER parties in FY 2008. Currently FES scientists and engineers are supporting the design activities, technical R&D, hardware procurement and other construction activities.

The FES program contributes to the World-Class Scientific Research Capacity goal by managing a program of fundamental research into the nature of fusion plasmas and the means for confining plasma to yield energy. This includes: 1) exploring basic issues in plasma science; 2) developing the scientific basis and computational tools to predict the behavior of magnetically confined plasmas; 3) using the advances in tokamak research to enhance the initiation of the burning plasma physics phase of the FES program; 4) exploring innovative confinement options that offer the potential of more attractive fusion energy sources in the long term; 5) advancing our understanding of high energy density laboratory plasmas; 6) developing the cutting edge technologies that enable fusion facilities to achieve their scientific goals; and 7) carrying out research on innovative materials to establish the economic feasibility and environmental quality of fusion energy.

The overall effort requires operation of a set of unique and diversified experimental facilities, ranging from smaller-scale university experiments to large national facilities that involve extensive collaborations. These facilities provide scientists with the experimental data to validate theoretical understanding and computer models-leading ultimately to an improved predictive capability for fusion science. Scientists from the U.S. also participate in leading edge experiments on fusion facilities abroad and conduct comparative studies to supplement the scientific understanding they can obtain from domestic facilities.

Operation of the major fusion facilities will be focused on science issues relevant to ITER design and operation. The United States is an active participant in the International Tokamak Physics Activity, which facilitates identification of high priority research for burning plasmas in general, and for ITER specifically, through workshops and assigned tasks. In addition, there will be continuing efforts to investigate simulations of fusion plasmas in collaboration with the Office of Advanced Scientific Computing Research.

(a) Science Subprogram
Technical Contact: Darlene Markevich, 301-903-4920, darlene.markevich@science.doe.gov

The Science subprogram seeks to develop the physics knowledge needed to advance the FES program. Research is conducted on small to large-scale confinement devices to study physics issues relevant to fusion and plasma physics and to the production of fusion energy. Experiments on these devices are used to explore the limits of specific confinement concepts, as well as study associated physical phenomena.

Grant applications/proposals are sought in all areas of plasma science relevant to fusion energy. Priority will be given to the following research topics: (1) theory and modeling to provide the foundations for integrated simulation of fusion systems; (2) the development and application of new diagnostic techniques for investigating edge and pedestal physics.

(b) Enabling R&D Subprogram
Technical Contact: Gene Nardella, 301-903-4956, gene.nardella@science.doe.gov

The Enabling R&D subprogram supports the advancement of fusion science in the nearer-term by carrying out research on technological topics that: (1) enable domestic experiments to achieve their full performance potential and scientific research goals; (2) permit scientific exploitation of the performance gains being sought from physics concept improvements; (3) allow the U.S. to enter into international collaborations gaining access to experimental conditions not available domestically; and (4) explore the science underlying these technological advances.

Grant applications/proposals are sought in enabling technologies relevant to fusion energy. Priority will be given to the following research topics: (1) plasma facing materials/components, (2) structural and special purpose materials, and (3) breeding blankets.

V. High Energy Physics (HEP)

Program Website: http://www.sc.doe.gov/hep

The mission of the High Energy Physics (HEP) program is to understand how our universe works at its most fundamental level. We do this by discovering the elementary constituents of matter and energy, probing the interactions between them, and exploring the basic nature of space and time itself.

The HEP program focuses on three scientific frontiers:

- *The Energy Frontier,* where powerful accelerators are used to create new particles, reveal their interactions, and investigate fundamental forces;
- *The Intensity Frontier,* where intense particle beams and highly sensitive detectors are used to pursue alternate pathways to investigate fundamental forces and particle interactions by studying events that occur rarely in nature; and
- *The Cosmic Frontier,* where ground and space-based experiments and telescopes are used to make measurements that will offer new insight and information about the nature of dark matter and dark energy, to understand fundamental particle properties and discover new phenomena.

Together, these three interrelated and complementary discovery frontiers offer the opportunity to answer some of the most basic questions about the world around us. All grant proposals should address specific research goals in one or more of these frontiers, or else explain how the proposed research or technology development supports the broad scientific objectives of the HEP program.

There are three broad areas within HEP that support research and technology development aimed at these objectives. New proposals should generally focus on one of these areas.

a) Experimental High Energy Physics Research

Technical Contact: Eli Rosenberg, 301-903-3711, eli.rosenberg@science.doe.gov

The experimental HEP research effort supports experiments utilizing man-made and naturally occurring particle sources to study fundamental particles and their interactions. This subprogram also provides graduate and postdoctoral research training for the next generation of scientists, equipment for experiments, and related computational support.

Topics studied in the experimental research program include, but are not limited to: proton-(anti)proton collisions at the highest possible energies; studies of neutrino properties using accelerator-produced neutrino beams as well as neutrinos from nuclear reactors; sensitive measurements of rarely occurring phenomena that can indicate new physics beyond the Standard Model; measurements of dark energy; and detection of the particles that make up cosmic dark matter.

b) Theoretical High Energy Physics Research
Technical Contact: C.N. Leung, 301-903-3715, cn.leung@science.doe.gov

The theoretical HEP research subprogram provides the vision and mathematical framework for understanding and extending the knowledge of particles, forces, space-time, and the universe. This subprogram also provides graduate and postdoctoral research training for the next generation of scientists and computational resources needed for theoretical calculations. Topics studied in the theoretical research program include, but are not limited to: phenomenological and theoretical studies that support the experimental research program, both in understanding the data and in finding new directions for experimental exploration; developing analytical and numerical computational techniques for these studies; and to find theoretical frameworks for understanding fundamental particles and forces at the deepest level possible.

c) Advanced Technology Research and Development
Technical Contact: Phil Debenham, 301-903-3641, phil.debenham@science.doe.gov

The advanced technology R&D subprogram develops the next generation of particle accelerator and detector technologies for the future advancement of high-energy physics and other sciences, supporting world-leading research in the physics of particle beams and fundamental advances in particle detection. This subprogram also provides graduate and postdoctoral research training, equipment for experiments and related computational efforts.

This subprogram supports long-range, exploratory research aimed at developing new concepts. Topics studied in the accelerator science program include, but are not limited to: analytic and computational techniques for modeling particle beams; novel acceleration concepts; muon colliders and neutrino factories; the science of high gradients in room-temperature accelerating cavities; high-brightness beam sources; and cutting-edge beam diagnostic techniques. Topics studied in the detector R&D program include, but are not limited to: low-mass, high channel density charged particle tracking detectors; high resolution, fast-readout calorimeters and particle identification detectors; improving the radiation tolerance of particle detectors; and advanced electronics and data acquisition systems.

VI. Nuclear Physics (NP)
Program Website: http://www.sc.doe.gov/np

The Nuclear Physics (NP) program seeks to discover, explore, and understand all forms of nuclear matter. The fundamental particles that compose nuclear matter-quarks and gluons-are relatively well understood, but exactly how they fit together and interact to create different types of matter in the universe is still largely not understood. To solve this mystery, the NP program supports experimental and theoretical research-along with the development and operation of particle accelerators and advanced technologies-to create, detect, and describe the different forms and complexities of nuclear matter that can exist in the universe, including those that are no longer found naturally in our universe. The NP program also produces stable and radioactive isotopes that are critical for the Nation.

To carry out this research, nuclear physics focuses on three broad yet tightly interrelated areas of inquiry. These areas are described in *The Frontiers of Nuclear Science* http://www.sc.doe.gov/np/nsac/nsac.html, a long range plan for nuclear science released in 2007 by the Nuclear Science Advisory Committee (NSAC). The three frontiers are: Quantum Chromodynamics, Nuclei and Nuclear Astrophysics, and Fundamental Symmetries and Neutrinos. To address these frontiers, specific questions are addressed by the research activities of each subprogram supported by the Office of Nuclear Physics:

(a) Medium Energy Nuclear Physics
Technical Contact: W. B. Tippens, 301-903-3904, brad.tippens@science.doe.gov

The Medium Energy subprogram focuses primarily on questions having to do with Quantum Chromodynamics (QCD) and the behavior of quarks inside protons and neutrons. Specific questions that are being addressed include: *What is the internal landscape of the nucleons? What does QCD predict for the properties of strongly interacting matter? What governs the transition of quarks and gluons into pions and nucleons? What is the role of gluons and gluon self-interactions in nucleons and nuclei?* One major goal, for example, is to achieve an experimental description of the substructure of the proton and the neutron. The subprogram supports investigations into a few aspects of the second frontier, Nuclei and Nuclear Astrophysics, such as the question: *What is the nature of the nuclear force that binds protons and neutrons into stable nuclei?* The subprogram also examines aspects of the third area, Fundamental Symmetries and Nuclei, including the questions: *Why is there now more visible matter than antimatter in the universe? What are the unseen forces that were present at the dawn of the universe, but disappeared from view as it evolved?* In pursuing these goals the Medium Energy subprogram supports different experimental approaches primarily at the Thomas Jefferson National Accelerator Facility and the Relativistic Heavy Ion Collider.

(b) Heavy Ion Nuclear Physics
Technical Contact: G. Rai, 301-903-4702, gulshan.rai@science.doe.gov

The Heavy Ion subprogram supports experimental research that investigates the frontier of Quantum Chromodynamics (QCD) by attempting to recreate and characterize new and predicted forms of matter and other new phenomena that might occur in extremely hot, dense nuclear matter and which have not existed since the Big Bang. This subprogram addresses what happens when nucleons "melt." QCD predicts that nuclear matter can change its state in somewhat the same way that ordinary matter can change from solid to liquid to gas. The fundamental questions addressed include: *What are the phases of strongly interacting matter, and what roles do they play in the cosmos? What governs the transition of quarks and gluons into pions and nucleons? What determines the key features of QCD, and what is their relation to the nature of gravity and spacetime?* Experimental research is carried out primarily using the U.S. Relativistic Heavy Ion

Collider (RHIC) facility and the Large Hadron Collider (LHC) at the European Organization for Nuclear Research (CERN).

(c) Low Energy Nuclear Physics
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The Low Energy subprogram aims primarily at answering the overarching questions associated with the second frontier identified by NSAC- Nuclei and Nuclear Astrophysics. These questions include: *What is the nature of the nucleonic matter? What is the origin of simple patterns in complex nuclei? What is the nature of neutron stars and dense nuclear matter? What is the origin of the elements in the cosmos? What are the nuclear reactions that drive stars and stellar explosions?* Major goals of this subprogram are to develop a comprehensive description of nuclei across the entire nuclear chart, to utilize rare isotope beams to reveal new nuclear phenomena and structures unlike those that are derived from studies using stable nuclei, and to measure the cross sections of nuclear reactions that power stars and spectacular stellar explosions and are responsible for the synthesis of the elements. The subprogram also investigates aspects of the third frontier of Fundamental Symmetries and Neutrinos. Questions addressed in this frontier include: *What is the nature of the neutrinos, what are their masses, and how have they shaped the evolution of the universe? Why is there now more visible matter than antimatter in the universe? What are the unseen forces that were present at the dawn of the universe but disappeared from view as the universe evolved?* The subprogram seeks to measure, or set a limit on, the neutrino mass and to determine if the neutrino is its own antiparticle. Experiments with cold neutrons also investigate the dominance of matter over antimatter in the universe, as well as other aspects of Fundamental Symmetries and Interactions.

(d) Nuclear Theory (including the Nuclear Data subprogram)
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The Nuclear Theory subprogram supports theoretical research at universities and DOE national laboratories with the goal of improving our fundamental understanding of nuclear physics, interpreting the results of experiments, and identifying and exploring important new areas of research. This subprogram addresses all three of the field's scientific frontiers described in NSAC's long range plan, which are Quantum Chromodynamics (QCD), Nuclei and Nuclear Astrophysics, and Fundamental Symmetries and Neutrinos, and the associated specific questions listed for the experimental subprograms above.

Theoretical research on QCD (the fundamental theory of quarks and gluons) addresses how the properties of the nuclei, hadrons, and nuclear matter observed experimentally arise from this theory, how the phenomena of quark confinement arises, and what phases of nuclear matter occur at high densities and temperatures. In Nuclei and Nuclear Astrophysics, theorists investigate a broad range of topics, including calculations of the properties of stable and unstable nuclear species, the limits of nuclear stability, the various types of nuclear transitions and decays, how nuclei arise from the forces between nucleons, and how nuclei are formed in cataclysmic astronomical events such as supernovae. In Fundamental Symmetries and Neutrinos, nucleons and nuclei are used to test the Standard Model, which describes the interactions of elementary particles at the most fundamental level. Theoretical research in this area is concerned with determining how various aspects of the Standard Model can be explored through nuclear physics experiments, including the interactions of neutrinos, unusual nuclear transitions, rare decays, and high-precision studies of cold neutrons.

Nuclear Theory activities at DOE also include the Nuclear Data subprogram, which compiles, maintains and distributes a database of information on nuclear properties and reactions that is of critical interest both to researchers and to developers of industrial applications of nuclear technology.

The NP program also supports the development of the tools and capabilities that make the fundamental research possible, and is the steward of the isotopes program for the nation:

(e) Accelerator Research and Development for Current and Future Nuclear Physics Facilities
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The Nuclear Physics program supports a broad range of activities aimed at research and development related to the science, engineering, and technology of heavy-ion, electron, and proton accelerators and associated systems. Areas of interest include the R&D technologies of the Brookhaven National Laboratory's Relativistic Heavy Ion Collider (RHIC), with heavy ion and polarized proton beam; the development of an electron-ion collider (EIC); linear accelerators such as the Continuous Electron Beam Accelerator Facility (CEBAF) at the Thomas Jefferson National Accelerator Facility (TJNAF); and development of devices and/or methods that would be useful in the generation of intense rare isotope beams for the next generation rare isotope beam accelerator facility (FRIB).

(f) Isotope Development and Production for Research and Applications
Technical Contact: J. Pantaleo, 301-903-2525, john.pantaleo@science.doe.gov

The Isotope Development and Production for Research and Applications subprogram supports the production and development of production techniques of radioactive and stable isotopes that are in short supply. The program provides facilities and capabilities for the production of research and commercial stable and radioactive isotopes, scientific and technical staff associated with general isotope research and production, and a supply of critical isotopes to address the needs of the Nation. Isotopes are made available by using the Department's unique facilities, the Brookhaven Linear Isotope Producer (BLIP) at BNL and the Isotope Production Facility (IPF) at LANL, of which the subprogram has stewardship responsibilities. The Program also coordinates and supports isotope production at a suite of university, national laboratory, and commercial accelerator and reactor facilities throughout the Nation to promote a reliable supply of domestic isotopes. Topics of interest include research that is focused on the development of advanced, cost-effective and efficient technologies for producing, processing, recycling and distributing isotopes in short supply. This includes innovative approaches to model and predict behavior and yields of targets undergoing irradiation in order to minimize target failures during routine isotope production.

Merit Review

Applications will be subjected to scientific merit review (peer review) and will be evaluated against the following evaluation criteria listed in descending order of importance as codified at 10 CFR 605.10(d):

1. Scientific and/or Technical Merit of the Project
2. Appropriateness of the Proposed Method or Approach
3. Competency of the Research Team and Adequacy of Available Resources
4. Reasonableness and Appropriateness of the Proposed Budget
5. Relevance to the mission of the specific program (e.g., ASCR, BER, BES, FES, HEP, or NP) to which the application is submitted
6. Leadership within the scientific community.

The evaluation will include program policy factors such as the relevance of the proposed research to the terms of the announcement and the agency's programmatic needs. It should be noted that external peer reviewers are selected on the basis of their scientific expertise and the absence of conflict-of-interest issues. Non-federal reviewers may be used, and submission of an application constitutes agreement that this review process is acceptable to the investigator(s) and the submitting institution.

For Criterion 5, the missions of the program areas are:

Advanced Scientific Computing Research (ASCR): To discover, develop, and deploy the computational and networking capabilities that enable researchers in the scientific disciplines to analyze, model, simulate, and predict complex phenomena important to the Department of Energy. A particular challenge of this program is fulfilling the science potential of emerging multi-core computing systems and other novel "extreme-scale" computing architectures, which will require significant modifications to today's tools and techniques.

Biological and Environmental Research (BER): To understand complex biological, climatic, and environmental systems across spatial and temporal scales ranging from sub-micron to the global, from individual molecules to ecosystems, and from nanoseconds to millennia. This is accomplished by exploring the frontiers of genome-enabled biology; discovering the physical, chemical and biological drivers of climate change; and seeking the molecular determinants of environmental sustainability and stewardship.

Basic Energy Sciences (BES): To support fundamental research to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels in order to provide the foundations for new energy technologies and to support other aspects of DOE missions in energy, environment, and national security.

Fusion Energy Sciences (FES): To expand the fundamental understanding of matter at very high temperatures and densities and the scientific foundations needed to develop a fusion energy source. This is accomplished by studying plasmas under a wide range of temperature and density, developing advanced diagnostics to make detailed measurements of their properties, and creating theoretical/computational models to resolve the essential physics.

High Energy Physics (HEP): To understand how our universe works at its most fundamental level. This is accomplished by discovering the most elementary constituents of matter and energy, probing the interactions between them, and exploring the basic nature of space and time itself.

Nuclear Physics (NP): To discover, explore, and understand all forms of nuclear matter. The fundamental particles that compose nuclear matter-quarks and gluons-are relatively well understood, but exactly how they fit together and interact to create different types of matter in the universe is still largely not understood. To solve this mystery, the NP program supports experimental and theoretical research-along with the development and operation of particle accelerators and advanced technologies-to create, detect, and describe the different forms and complexities of nuclear matter that can exist in the universe, including those that are no longer found naturally.

Application Review Information.

Preference for Applications that promote and enhance the objectives of the American Recovery and Reinvestment Act of 2009, P.L. 111-5.

PROGRAM FUNDING:

It is anticipated that up to $25M of Recovery Act funds will be available for grant awards in FY 2010. This amount is approximate and subject to availability of funds. It is anticipated that 30-50 awards will be made in Fiscal Year 2010. The number of awards will be contingent on satisfactory peer review, the availability of appropriated funds, and the size of the awards. Applications may request project support for up to five years, with out-year support contingent on the availability of funds, progress of the research, and programmatic needs. The typical award size is expected to be $750,000 over five years. The minimum award size is $150,000 per year over five years. Institutions are encouraged to propose research expenditures as close to this funding minimum as possible. DOE is under no obligation to pay for any costs associated with the preparation or submission of an application. DOE reserves the right to fund, in whole or in part, any, all, or none of the applications submitted in response to this FOA.

The Catalog of Federal Domestic Assistance (CFDA) number for this program is 81.049, and the solicitation control number is ERFAP 10 CFR Part 605.

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